



Acromioaxillosuprasternal Notch Index and Old Head and Anatomic Neck Criteria in Predicting Difficult Laryngoscopy in Tracheal Intubation in Children under General Anesthesia

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ABSTRACT

Introduction: Currently, various methods are being used for determining difficult laryngoscopy. The present study aimed to compare the acromioaxillosuprasternal notch index function with the old head and neck anatomic criteria in predicting difficult laryngoscopy with respect to trachea intubation under general anesthesia in children.

Materials and Methods: In this cross-sectional study, 379 children under intubation with general anesthesia entered the study. Patients were divided into two groups: easy laryngoscopy (grades 1 and 2) and difficult laryngoscopy (grades 3 and 4) based on Cormack-Lehane score. The thyromental distance systems, height to thyromental distance, Upper-Lip-Bite test, neck circumference, and acromioaxillosuprasternal notch index were studied and compared. **Results:** Laryngoscopy was difficult in 48 subjects (38 were grade 3 and 10 were grade 4). Interestingly, no significant difference was detected between easy and difficult laryngoscopies based on the thyromental distance, neck circumference, height to thyromental distance, and acromioaxillosuprasternal notch index ($P > 0.05$). height to thyromental distance, acromioaxillosuprasternal notch index, and neck circumference have a sensitivity of 32.2%, 47.9%, 51.1%, respectively, and the specificity was 52.7%, 45.6%, and 48.9%, respectively.

Conclusion: Neck circumference and acromioaxillosuprasternal notch index outperform the height to thyromental distance. On the other hand, Modified Mallampati test is better than Upper-Lip-Bite test in determining difficult laryngoscopy in children.

INTRODUCTION

Protection of airways during surgery is crucial in anesthesia as it provides sufficient respiration. In this regard, laryngoscopy and endotracheal intubation (ETT) are the most common ways to protect the airways and maintain respiration. ETT is one of the most efficient and safe methods for providing air from different aspects, albeit with some side effects (1). Laryngoscopy and ETT can lead to tachycardia, hypotension, and heart rate variation, which further leads to myocardial ischemia and intra-cerebral pressure in vulnerable individuals (2). A common issue during intra-trachea intubation is the difficulty of the procedure, which leads to mortality, hypoxia, aspiration, and anesthesia-dependent disabilities in case of failure (3). Difficult intubation is defined as the condition when the anesthesiologist fails to see the glottis by laryngoscope (4). The rate of difficulty in intubation is variable, ranging from 1.5% to 13%. The factors affecting intubation include gender, age, race,

obesity, leanness, and soft tissue around the larynx (5, 6). One of the main concerns of the anesthesiologist is predicting difficult intubation in patients. Thus, different techniques have been developed based on indexes, such as Mallampati index, anatomical positions of the head and neck, neck circumference, Upper-Lip-Bite test (ULBT), and height to thyromental distance (HTMD) (7-9); however, no consensus has been reached on these methods.

The neck circumference method is an effective technique for laryngoscopy prediction and difficult intubation (10). In the HTMD method, a distance > 25 mm predicts difficult intubation with 81% sensitivity and 91% specificity (11). In the ULBT method, based on the extent to which the lower jaw teeth can bite the upper lip, the teeth are divided into three classes. Intubation is easy in the first and second class, while difficult intubation occurs in the third class, in which the teeth cannot touch the upper lip (12). A newly studied index is acromioaxillosuprasternal notch index (AASI) (13), in which a line is drawn between the upper surface of acromi-

on and the upper limit of the axilla (a). The second line (b) is drawn from the suprasternal notch in a vertical direction on line (a). A part of line a which is placed above a and b line intersection (c) is obtained on line a (C/A) in AASI.

Although different methods and techniques with variable sensitivity and specificity have been used for the prediction of patients with difficult intubation, a comparison between old techniques (neck circumference, HTMD, ULBT) and new techniques (AASI) has not yet been carried out. Thus, the present study compared and investigated these methods.

MATERIALS AND METHODS

This prospective cross-sectional study was conducted on 379 children hospitalized at the Imam Hossein Medical Center during 2016–2017. The inclusion criteria were children aged 1–18 years under general anesthesia with ASA class I and II (America Committee Association). The exclusion criteria were malformations of airways, lack of teeth, history of intubation, previous surgery on the airway, apnea sleep, rheumatism diseases in head and jaw, spinal cord fracture, and trauma or specific pathology in the upper airways. Before anesthesia induction, height parameters (cm), thyromental distance (cm), RHTMD, ULBT test, body weight (kg), body mass index (BMI) index, neck circumference (measuring neck circumference in Adam's apple when the head of the newborn is in neutral position and the mouth is open), demographic data, and AASI were verified by the researcher. Monitoring during anesthesia includes electrocardiogram (EKG), pulse oximeter, capnography, and hypotension. After pre-oxygenation for 5 min with 100% oxygen, anesthesia was induced with IV 5 mg/kg thiopental, IV 2 mcg/kg fentanyl, IV 0.5 mg/kg atracurium, and IV 2 mg/kg lidocaine. After using a holding mask for 2 min with Macintosh blade number 3, child sniffing was performed by an anesthesiologist with the standard tube based on the age. During laryngoscopy, without external manipulation of the larynx, the larynx view grading was recorded using the Cormack-Lehane score. Subsequently, the children were divided into four groups: grading 1 - seeing vocal folds completely; grading 2 - seeing lower glottis; grading 3 - seeing epiglottis; and grading 4 - not-seeing epiglottis. Difficult laryngoscopy was determined by Cormack-Lehane grades 3 and 4. Modified Mallampati test (MMT) classification was as follows: class 1 - soft palate-uvula-tonsillar pillars; class 2 - soft palate-uvula but unclear tonsillar pillar; class 3 - soft palate and uvula; and class 4 - soft palate is not observed. The new tests consist of ULBT, which was conducted by covering the upper lip mucus by lower incisors. This phenomenon was categorized into three grades: grade 1 - lower incisors cover the upper lip mucus completely; grade 2 - lower incisors only touch the upper lip but cover the mucus; and grade 3 - lower incisors do not reach the upper lip. Grade 1 and grade 2 present easy laryngoscopy, while grade 3 is difficult laryngoscopy.

AASI measurement method: Line A is the vertical line

between the acromion notch and upper axilla; Line B is the vertical line from the suprasternal notch on line A; Line C is a part of line A which is placed on the top of lines A and B intersection. AASI is defined as C divided on A.

Subsequently, the data gathered during anesthesia and laryngoscopy findings were recorded in the questionnaire. The patients with grades 1 and 2 had easy laryngoscopy, while patients with grades 3 and 4 had difficult laryngoscopy (14). Data analysis was carried out using SPSS software version 22. $P < 0.05$ was considered as statistically significant. Quantitative data were expressed as mean and standard deviation and qualitative data as the frequency or percentage. The analyses were conducted using chi-square and independent t-tests. The ROC curve was used to determine the sensitivity, specificity, positive and negative values, area under the curve, and cutoff threshold.

RESULTS

In this study, from among 379 participants (250 males and 129 females), laryngoscopy was easy in 331 participants (195 patients: grade 1; 136 patients: grade 2) and difficult in 48 participants (38 patients: grade 3; 10 patients: grade 4). The mean age and BMI of patients were 6.43 ± 3.48 and 23.07 ± 1.26 , respectively. However, no significant difference was detected between easy and difficult laryngoscopy patients in terms of age, gender, and BMI ($P > 0.05$). Also, no significant difference was observed between the laryngoscopy methods based on thyromental distance and neck circumference ($P > 0.05$) (Table 1). Patients were divided into three grades based on the ULBT system: grade 1 - 58.8%, grade 2

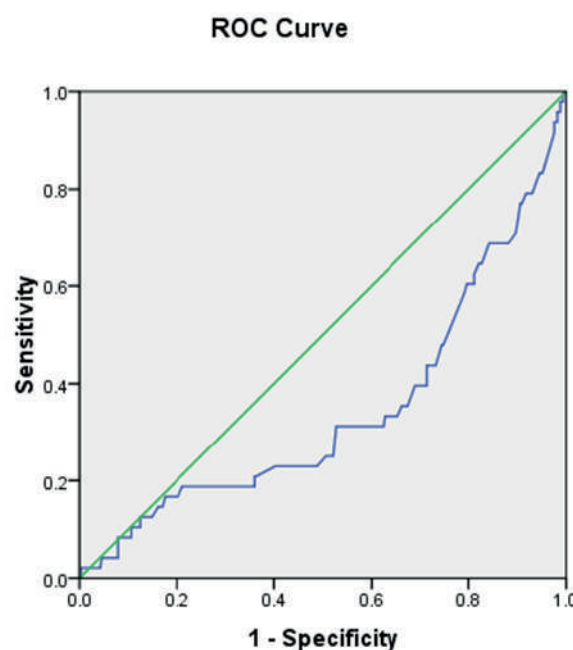


Figure 1. ROC curve of the HTMD in difficult laryngoscopy. (Abbreviations: ROC curve: receiver operating characteristic curve, HTMD: height to thyromental distance)

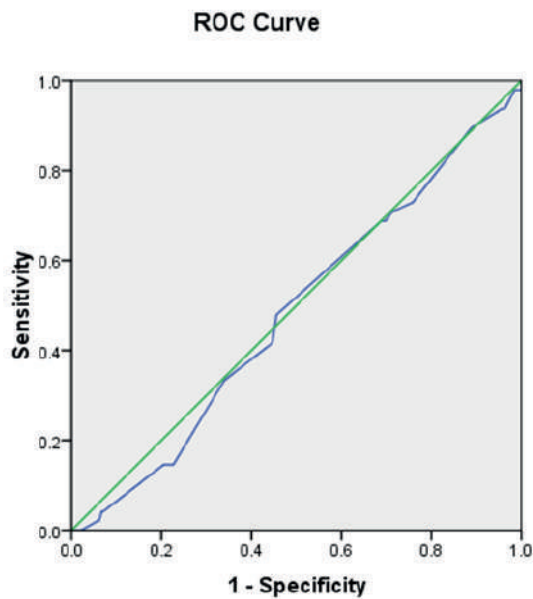


Figure 2. ROC curve of the AASI in difficult laryngoscopy.
(Abbreviations: ROC curve: receiver operating characteristic curve, AASI: acromioaxillosuprasternal notch index) HTMD: height to thyromental distance)

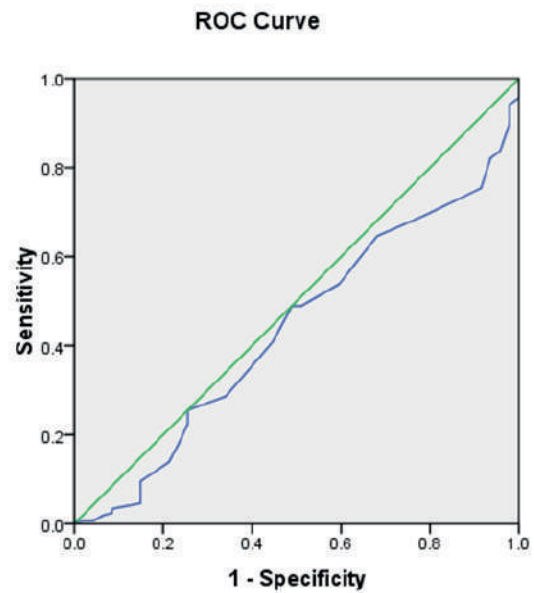


Figure 3. ROC curve of the neck circumference in difficult laryngoscopy.
(Abbreviations: ROC curve: receiver operating characteristic curve)

- 36.7%, and grade 3 - 4.5%. Based on the MMT system, 51.5% patients were in grade 1, 36.1% in grade 2, 10.3% in grade 3, and 1.8% patients in grade 4. A significant difference was detected between easy and difficult laryngoscopy based on ULBT and MMT ($P < 0.001$). The mean HTMD mean was 19.21 ± 4.69 and mean AASI was 3.26 ± 0.71 . There was no significant difference between the two laryngoscopy methods based on thyromental distance

and AASI ($P > 0.05$) (Table 2).

According to the ROC curve, HTMD with cutoff as 18.70, 31.2% sensitivity, and 52.7% specificity (Fig 1); AASI with cutoff as 3.10, 47.9% sensitivity, and 45.6% specificity (Fig. 2); and neck circumference with cutoff as 24.25, 51.1% sensitivity, and 48.9% specificity (Fig. 3) undergo difficult laryngoscopy (Table 3).

Table 1. Clinical variables examined in easy and difficult laryngoscopy

Variables	Easy laryngoscopy	Difficult laryngoscopy	P-value
Age (years) (mean \pm SD)	6.52 \pm 3.47	5.85 \pm 3.51	0.66
Gender	Male	(65.6%) 217	0.66
	Female	(34.4%) 114	
BMI (kg/m ²) (mean \pm SD)	22.49 \pm 10.09	27.03 \pm 10.70	0.52
Thyromental distance	5.62 \pm 1.12	5.27 \pm 1.04	0.63
Neck circumference	24.66 \pm 5.73	26.22 \pm 5.84	0.86

Abbreviation;
SD: standard deviation, BMI: body mass index

Table 2. Laryngoscopy type scoring systems in the difficult and easy laryngoscopy groups

Variables		Easy laryngoscopy	Difficult laryngoscopy	P-value
ULBT	Grade 1	(66.5%) 220	(6.3%) 3	0.001>
	Grade 2	(33.5%) 111	(58.3%) 28	
	Grade 3	0	(35.4%) 17	
MMT	Grade 1	(58.8%) 194	(2.1%) 1	0.001>
	Grade 2	(40%) 132	(10.4%) 5	
	Grade 3	(1.2%) 4	(72.9%) 35	
	Grade 4	0	(14.6%) 7	
HTMD		19.45±4.57	17.52±5.14	0.57
AASI		3.27±0.73	3.17±0.59	0.21

Abbreviations;

ULBT: Upper-Lip-Bite test, MMT: Modified Mallampati test, HTMD: height to thyromental distance,

AASI: acromioaxillosuprasternal notch index

DISCUSSION

Based on the current results and by considering laryngoscopy or Cormack-Lehane method as the standard and reference in ULBT method, patients with easy laryngoscopy were in grade 1, and patients with difficult laryngoscopy were in grades 2 and 3. In the MMT method, maximal cases with easy laryngoscopy were in grades 1 and 2, and cases with difficult laryngoscopy were in grade 3 and 4. The two qualitative methods were effective and useful in determining difficult laryngoscopy; however, MMT outperforms ULBT. Among the quantitative methods, which include HTMD, AASI, and neck circumference, the neck circumference and HTMD methods showed high sensitivity. Although the AASI method has satisfactory specificity, the neck circumference method is better due to its high sensitivity and specificity.

In a study by Kamranmanesh et. al on AASI as a new method for determining difficult laryngoscopy, the area under the curve for AASI was >0.49. AASI had lower false negative and higher predicted values as compared to MMP (sensitivity, positive prediction value, and precision) (15). In the current study, the area under the curve for AASI was 0.483, which was similar to our obtained value. In this study,

MMT was considered a precise method for determining difficult laryngoscopy. Gonzalez et al. explored the importance of neck circumference in predicting laryngoscopy and difficult intubation. They concluded that laryngoscopy and difficult intubation are associated with thyromental distance, increase in neck circumference, BMI, and Mallampati score. In addition, neck circumference was effective in predicting difficult laryngoscopy and intubation with 92% sensitivity index as well as using Mallampati index (16). Herein, neck circumference was estimated to have 51.1% sensitivity and 48.9% specificity for determining difficult laryngoscopy; this method was superior to that of the other methods. The study by Safavi et al. compared HTMD, MMT, and ULBT in difficult laryngoscopy; 41/603 patients had difficult laryngoscopy (grades 3 and 4). The area under the curve was relatively low for MMT and RHTMD. The cutoff point was 21.06 for RHTMD, the sensitivity was 75.6%, and the specificity was 58.5%. The present study concluded that RHTMD is better than ULBT in determining difficult laryngoscopy in the population (14).

Sensitivity and specificity were 31.2% and 52.7% for HTMD in the current study. ULBT method was useful in

Table 3. Sensitivity and specificity of the indexes studied in the study based on the ROC curve

Variables	Area	Cut-off	Sensitivity	Specificity
HTMD	0.345	18.70	31.2%	52.7%
AASI	0.483	3.10	47.9%	45.6%
Neck	0.561	24.25	51.1%	48.9%

Abbreviations;

HTMD: height to thyromental distance, AASI: acromioaxillosuprasternal notch index

determining difficult laryngoscopy. Another study indicates that AASI sensitivity with 0.79 area under the curve is 66.67%, but MMT, NC/TMD, and RHTMD tests, although old, exhibit 0.626, 0.531, and 0.537 area under the curve and, hence, are not optimal predictor tests (17). The sensitivity of ULBT was about 52.38%, deeming it as a satisfactory predictor (17). In the current study, AASI sensitivity with 0.483 area under curve was 47.9%, and ULBT test prediction was satisfactory. In another study by Hussain Khan, which compared ULBT with Mallampati, the sensitivity, specificity, and precision of ULBT in predicting difficult laryngoscopy and intubation were higher than the thyromental index, sternomental distance, and interincisor distance (9). In the current study, ULBT predicted difficult laryngoscopy.

Therefore, based on the results of previous studies regarding the issue of new and old methods for difficult laryngoscopy, satisfactory methods were available for determining difficult intubation; however, among these, neck circumference and AASI outperformed the HTMD. On the other hand, MMT is better than ULBT in determining difficult laryngoscopy in children. AASI is a novel and adequate method to assess difficult laryngoscopy. Therefore, due to the limited number of studies, further studies are needed in this field.

CONCLUSION

Neck circumference and acromioaxillosuprasternal notch index outperform the height to thyromental distance. On the other hand, Modified Mallampati test is better than Upper-Lip-Bite test in determining difficult laryngoscopy in children.

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AUTHOR CONTRIBUTIONS

None

CONFLICT OF INTERESTS

None

ETHICAL STANDARDS

None

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